

# September 1998 Highlights of the Pulsed Power Inertial Confinement Fusion Program

In September we had 18 Z shots: nine for radiation effects in collaboration with the Defense Threat Reduction Agency (DTRA), four to prepare for equation-of-state (EOS) and shock physics experiments at liquid helium temperatures, three LLNL weapon physics shots, one shot with current monitors located in the anode region, and one short circuit shot.

The HEDP advisory committee that met in August to evaluate the Z shot plans for 1999 had high praise for our experimental progress. The members recommended that efforts on z-pinch physics, weapon physics, and radiation effects increase and that the ICF effort focus on one or two target configurations. Subsequent to the meeting, our FY99 budget required that we reduce our planned "shooting days" from 240 to 200, which is essentially the same as in FY98, with 186 shots.

In a proof-of-principle experiment, we demonstrated the use of

Z in the short circuit mode to produce continuously increasing pressure loading of an iron sample to 300 kbars. The magnetic pressure alone, without any radiation from a z pinch, provides the force on the sample during a 100-ns pulse. The resulting thermodynamic states are nearly isentropic. Direct measurement of the free surface velocity of the iron with a velocity interferometer shows the onset of the 130-kbar phase transition from a hexagonal-close-packed crystal to a body-centered-cubic (bcc) crystal, the completion of the phase transition, and isentropic compression in the bcc phase (see figure). This new capability is of particular interest for EOS applications to stockpile stewardship and provides new information on the kinetics of the phase transition that is hard to determine from conventional shock compression experiments. Isentropic EOS measurements have been a long-standing goal of the shock physics community; smooth compressions with gas guns are difficult because of the strong shocks produced, and accurate measurements are difficult using the small sample dimensions possible with other sources. With improvements in the technique, it should be possible to obtain physical property data under isentropic compression to 3 Mbars on Z and to 15 Mbars on a future, higher current (~40 MA) facility.

A general-purpose cryogenic target system is being developed for precision EOS and shock physics experiments on Z (Fig. 2). Nova experiments with very small liquid deuterium samples have shown an unexpected amount of compressibility during molecular dissociation to the metallic phase. A particular goal of the EOS experiments on Z is to obtain liquid D<sub>2</sub> data at 20K from uniform radiation drive over relatively large sample sizes (a few millimeters).

The DTRA radiation effects shots in September are part of a series to develop a scaling database for DECADE-Quad and for future z-pinch facilities such as X-1 and to prepare a nuclear weapons effects test environment on Z. We had found that nickel cladding on titanium allowed thinner wires to be fabricated, and tests by Imperial College and Cornell University indicated that the wires would explode more uniformly than pure Ti. The wire number and array diameter for the Ni-clad wires were optimized on Z. The best results produced 400 kJ of 1 - 5 keV x-rays (120 kJ from the Ti K-shell at 4.8 keV and the remainder from the Ni and Ti L-shells). This is a 30% increase over our previous best of 300 kJ from pure Ti wire arrays or from Al K-shell radiators. Saturn, the next largest radiation effects simulator, can produce 100 kJ at 1 keV, 40 kJ at 3 keV and 10 kJ at 4.8 keV. These new Z capabilities provide more faithful sources for potential DTRA tests and for material databases to input in simulation codes.

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Archived copies of the Highlights beginning July 1993 are available at <http://www.sandia.gov/pulspow/hedcf/highlights>.

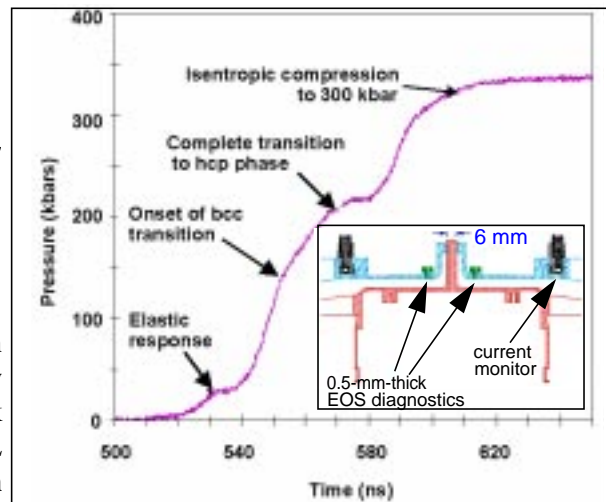


Fig. 1. Data from isentropic compression of 3-mm-dia, 0.5-mm-thick iron disk. Inset shows hardware setup.

Fig. 2. Installation on Z of liquid helium cryostat and active temperature control system for shock physics and EOS studies in a secondary hohlraum.

